PRE-OPERATIVE MEDICAL PLANNING SYSTEM AND METHOD FOR USE THEREOF

FIELD OF THE INVENTION

[0001] The present invention relates to methods and apparatus for pre-operative planning of orthopaedic surgical procedures.

BACKGROUND OF THE INVENTION

[0002] Introduction of digital radiology poses a sufficient challenge to hospital radiology, but also the orthopaedic department. This field describes a system and method-allowing surgeons to perform tasks of medical image analysis using manual tools using a computer based software. Specifically, the need for such a tool exists in the field of orthopaedic surgical procedures. Surgeons are still accustomed to planning treatment of bone fractures by using two-dimensional conventional x-ray images.

[0003] The common practice in planning treatment for orthopaedic trauma includes copying bone fragments (hereinafter ‘segments’) from x-ray images onto separate pieces of transparent paper. It is done twice in order to have copies of bone segments in two projections (AP and Lateral). The different fragments (e.g., segments) are aligned together and glued in the required positions to achieve an anatomic fracture reduction. Over the reduced patterns, the surgeon attempts to match the best available fixation devices and elements using templates of these devices and elements.

[0004] For joint arthroplasty, a template of the prosthesis, which is supplied by the manufacturer, is aligned to the X-Ray images of the patient. Once a correct position and angle are achieved, the template is glued to the film. This can only be used as a rough guide for the surgical procedure since the scaling of the X-Ray image is such that it is not always an exact reproduction of the bone segment and optimal positioning of the prosthesis may not be parallel to the viewed angle of the images.

[0005] The traditional technique, which is performed as described hereinabove by aligning templates to printed X-Ray films, suffers from several disadvantages:

- The dimensioning may not be representative of the actual object – scaling varies from 110%-120% of real size, due to a distorting effect known as divergence, whereas templates are supplied in fixed size.
- There is difficulty in saving or printing out the results in an organized and cost-effective manner.
- The planning is time-consuming and complicated.

[0006] Furthermore, introduction of advanced imaging techniques such as PACS systems will eliminate the handling of traditional X-Ray film from hospital centers. In such instances, the traditional pre-planning technique will require printout of X-Ray images on costly materials.

[0007] There is also another need that cannot be fulfilled using the traditional pre-planning technique, which is better control and education. It is common - for a chief surgeon to review and analyze procedures performed by his staff and explore multiple alternative treatments with his staff prior to the surgery.

[0008] U.S. Pat. No. 5,769,092 to Williamson presents a computer-assisted system to help perform a hip replacement. The system allows the surgeon to interact with 3D models of the relevant bones to select an appropriate replacement strategy. No registration of the anatomical structures of interest is available; the immobilization of the anatomical structures renders the intra-operating room planning to be difficult, since no trial movements can be performed on the immobilized structures. Moreover, Williamson's system does not allow the visualization of transparent 3D models of the anatomical structures. US Pat. No. 5,748,767 to Raab discloses a computer-aided surgery apparatus adapted to aid a medical practitioner in positioning a surgical instrument or implant when performing surgery on or examining portions of a patient. Pre-treatment and treatment coordinates are continually calculated with respect to a specially designed reference block attached to an electrogoniometer, wherein a mechanical linkage for maintaining the surgical tool in a fixed relationship with the reference block is required. Such machinations

of the probing process create a system that is relatively cumbersome for the practitioner using a hand-held transducer. Moreover, difficulty is obtained with which a prior imaging plane can be recaptured for comparison purposes, a problem which becomes even more significant with the use of hand-held transducer.

[0009] It is thus the purpose of the present invention to offer digital templating for pre-planning of orthopedic surgical procedures. It is the purpose of the present invention to allow the surgeon to calibrate the images, plan how to reduce the fracture or align implants, and apply fixation, using an interactive and user-friendly system. Additionally, it is the purpose of the present invention to enable review of various therapeutic options and have a better opportunity to choose the best. Additionally, the present invention enables the possibility of communication with operating room inventory systems. The present invention also enables producing reports, which include final pre planning images of reduced and fixed fractures as well as inventory, and part list reports. The further aspect of the present invention enables communicating of all data to and from other database systems.

SUMMARY OF THE INVENTION

[00010] The present invention relates to a method for pre-operative planning and simulation of orthopaedic surgical procedures using medical images. The method is comprised of the following steps: (a) obtaining medical images and making a composite view of an anatomical structure. This may be comprised of one or more images to provide a full-length view of the anatomical structure; (b) segmenting the anatomical structure- such as bone but not limited to bone segments- in the medical images, and manipulating the image segments to simulate a desired result of the orthopedic surgical procedure. (c) performing different measurements and analysis, such as length discrepancy, angle measurements, as well as more complex sets of measurements such as deformity analysis, structural relationship in terms of distances and angles to one another, (d) production of output images are wherein the obtained output images comprise features selected from the group of a plurality of n calibrated organs- a plurality of *m* organ segments; a plurality of *j* calibrated artificial elements wherein *n, m*, and *j* are integer numbers between 1 to 100; and/or at least one superposition of the calibrated artificial elements on the calibrated organs and/or organ segments. In one preferred embodiment of the

present invention, the medical images are X-ray images. In another embodiment, the medical images are combination of plurality of imaging techniques. In yet another embodiment, the medical images comprise a plurality of views of the same organs. Preferably, the procurement stage is done by transforming of the medical images to digital images. The obtaining step may also be comprised calibrating of images. It is noted that calibrating of images may include registration of different views, calibration of dimension and orientation, and/or image enhancements such as brightness and contrast adjustments, and edge detection. Calibration may also involve correction of distortions. In another preferred embodiment of the present invention, the segmenting step is performed manually by a medical expert (In another preferred embodiment of the present invention, the segmenting step is performed automatically, in the manner that the anatomical structure segments are segmented according to predefined rules. In yet another preferred embodiment of the present invention, the segmenting step is performed semi-automatically, in the manner that the segmenting step is performed automatically with the assistance of a medical expert. Preferably, the planning step also comprises simulating various positioning of the anatomical structure segments. Different positioning of the anatomical structure segments relates to reducing of fractures during trauma treatment, or relates to pre-designed treatments for distorted anatomical structures. Preferably, the artificial elements comprise implants; in the manner that superposition of implants and the segmented anatomical structure over non-segmented fragments of the anatomical structure is provided. The artificial elements may also comprise fixation elements, in the manner that superposition of members selected from fixators, fixators anchoring devices, and the segmented anatomical structure over non-segmented fragments of the anatomical structure is provided. A preferred embodiment may comprise a step of choosing a plurality of the fixation elements from a predefined database, and rules for correct positioning of the fixation elements so incorrect positioning of the fixation elements is prevented. The above method may additionally comprise a step of producing and storing output images and planning reports of a (he uses this word too often) large number of alternatives of the steps of segmenting and planning, for the purpose that the best alternative for medical treatment is selected from the choices; the planning report may also comprise part definition of the artificial elements selected for the treatment. The above method may additionally comprise a step of providing hard copies of the

output images and the planning reports of a selected set of the alternatives. The method also enables communicating the output images and the planning reports to a multitude of remote users.

[00011] The present invention also relates to an apparatus for pre planning and simulating of orthopedic surgical procedures using medical images which comprises: (a) segmenting means for defining and marking anatomical structure segments in the medical images, (b) planning means for planning the desired result of the orthopedic surgical procedure, which comprise means for producing output images, wherein the output images comprise features selected from the group of a plurality of n calibrated organs; a plurality of m organ segments; a plurality of j calibrated artificial elements wherein n,m,j are integer numbers between 1 to 100; and/or at least one superposition of the calibrated artificial elements on the calibrated organs and/or organ segments. (c) a memory for storing the medical images and the desired result, and (d) a display for displaying the medical images and the output images.

[00012] In one preferred embodiment of the present invention, the medical images are X-ray images. In another embodiment, the medical images are combination of plurality of imaging techniques. In yet another embodiment, the medical images comprise a plurality of views of the same organs

[00013] The apparatus may further comprise means for transforming the medical images to digital images. The apparatus according to the present invention may additionally comprise calibration means for images. The calibration means may be utilized for registration of different views, for dimension and orientation calibration, and for image enhancements comprising brightness and contrast adjustments, and edge detection. The calibration means may also be utilized for correction of image distortions. The segmenting means of the above apparatus, may be manually operated by a medical expert, or they may be automatically operated according to predefined rules. Additionally, the segmenting means may also be operated semi-automatically in the manner that the segmenting step is performed automatically with the assistance of a medical expert. The planning means of the present invention are mainly utilized for simulating different positioning of the anatomical structure segments: simulating reduction of fractures during trauma

treatment, and simulating pre-designed treatments for distorted organs. The artificial elements comprise implants; in the manner that superposition of implants and the segmented anatomical structure over non-segmented fragments of the anatomical structure is provided. The artificial elements also comprise fixation elements, in the manner that superposition of members selected from fixators, fixators anchoring devices, and the segmented anatomical structure over non-segmented fragments of the anatomical structure is provided. The apparatus of the present invention further comprises a predefined database comprising predefined sets of fixation elements. The apparatus may further comprise means for correct positioning of the fixation elements so incorrect positioning of the fixation elements is prevented. The apparatus according to the present invention may additionally comprise means for producing and storing output images and planning reports of plurality of alternatives, for the purpose that the best alternative for medical treatment is selected from the alternatives, and the planning reports comprise part definition of the artificial elements selected for the medical treatment. The apparatus according to the present invention may also comprise means for creating hard copies of the output images and the planning reports of a selected set of the alternatives. Additionally, the apparatus of the present invention may also comprise communicating means for communicating the output images and the planning reports to remote users.

BRIEF DESCRIPTION OF THE INVENTION

[00014] In order to understand the invention and to see how it may be implemented in practice, preferred embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawing, in which:

[00015] Fig. 1 is a flowchart of the process performed in the pre-planning system of the present invention;

[00016] Fig. 2A is a schematic view of X-Ray image of a broken bone as displayed on the pre planning system of the present invention;

[00017] Fig. 2B is a schematic view of X-Ray image of a different view of a broken bone;

[00018] Fig. 3A is a schematic view of X-Ray image of a broken bone with marked bone segment;

[00019] Fig. 3B is a schematic view of X-Ray image of a different view of a broken bone with marked bone segment;

[00020] Fig. 4A is a schematic view of X-Ray image of a reduced fracture;

[00021] Fig. 4B is a schematic view of X-Ray image of a different view of a reduced fracture;

[00022] Fig. 5A is a schematic view of X-Ray image of a bone with fixation elements;

[00023] Fig. 5B is a schematic view of X-Ray image of a different view of a bone with fixation elements;

[00024] Fig. 6A is a schematic view of a full pre-operative plan in accordance with the present invention;

[00025] Fig. 6B is a schematic view of a different view of a full pre-operative plan in accordance with the present invention;

[00026] Fig. 7A is a schematic view of a post-operative result in accordance with the present invention;

[00027] Fig. 7B is a schematic view of a different view of a post operative result in accordance with the present invention;

[00028] Fig. 8A is a flowchart describing rendering of a screw in accordance with the present invention;

[00029] Fig. 8A is a flowchart describing rendering of a fixation device in accordance with the present invention;

[00030] Fig. 9 is a flowchart of the process of osteotomy with artificial fixation devices in accordance with the present invention; and,

[00031] Fig. 10 is a flowchart of image rendering in accordance with one embodiment of the present invention.

[00032] Fig. 11 is a flowchart of image rendering in accordance with another embodiment present invention.

DETAILED DESCRIPTION OF THE INVENTION

[00033] The following description is provided, alongside all chapters of the present invention, so as to enable any person skilled in the art to make use of said invention and sets forth the best modes contemplated by the inventor of carrying out this invention. Various modifications, however, will remain apparent to those skilled in the art, since the generic principles of the present invention have been defined specifically to provide methods and apparatus for pre-operative planning of orthopedic surgical procedures.

[00034] The present invention is directed to a method for pre-planning and simulating of orthopaedic surgical procedures using medical images. The method comprises the following steps: (a) obtaining and displaying the medical images; (b) segmenting anatomical structure segments in the medical images; and (c) planning the desired result of the orthopaedic surgical procedure so output images are produced, wherein the obtained output images comprise features selected from the group of a plurality of *n* calibrated organs; a plurality of *m* organ segments; a plurality of *j* calibrated artificial elements wherein *n*, *m*, and *j* are integer numbers between 1 to 100; and/or at least one superposition of the calibrated artificial elements on the calibrated organs and/or organ segments.

[00035] The present invention also relates to an apparatus for pre planning and simulating of orthopaedic surgical procedures using medical images which comprises (a) segmenting means for defining and marking anatomical structure segments in the medical images, (b) planning means for planning the desired result of the orthopaedic surgical procedure, which comprise means for producing output images, wherein the output images comprise features selected from the group of a

plurality of *n* calibrated organs; a plurality of *m* organ segments; a plurality of *j* calibrated artificial elements wherein *n,m,j* are integer numbers between 1 to 100; and/or at least one superposition of the calibrated artificial elements on the calibrated organs and/or organ segments. (c) a memory for storing the medical images and the desired result, and (d) a display for displaying the medical images and the output images.

[00036] The term 'anatomical structure segment' refers according to the present invention to any segment of a anatomical structure that is defined and marked by a physician or other medical expert for the purpose of referring to this anatomical structure separately from the other objects on the image. Segmenting anatomical structure segment is done by the action of defining and marking. According to the present invention, the action of segmenting may be performed manually using interactive computer means such as a mouse or any other pointing device. Segmenting according to other embodiments may be performed automatically or semi automatically as described hereinafter. The segmenting action results in digital anatomical structure segments that are marked on the display.

[00037] The term 'medical images' refers according to the present invention to standard medical images that are produced by medical imaging devices such as X-Ray, CT, MRI, and others.

[00038] The term 'result of orthopedic surgical procedure' refers according to the present invention to the desired outcome of the orthopedic surgical procedure such as reduced fracture. The term 'desire' generally refers to the recuperation, healing and/or recovery of the body's organ in correlation and/or agreement with the predetermined purposes and intentions of the aforementioned orthopedic procedure. The result as pre-planned by the system of the present invention is demonstrated in the aforementioned output images.

[00039] The term 'output images' refers according to the present invention to pre-planning images that are produced by the present invention including fracture reduction positioning of broken bones and orthopedic implants and fixation elements.

[00040] The term 'orthopedic surgical procedure' refers according to the present invention to orthopedic operation for purposes such as bone fracture reduction.

[00041] The term 'fixators' refers according to the present invention to fixators, anchoring means, selected from screws, nails, anchors (plates), implants or any combination thereof.

[00042] Typically, the pre-planning system of the present invention will involve computer hardware and software, display, keyboard and pointing device (e.g., mouse), communication and hard copy devices. As the hardware components of the system may be standard computer components, it should be appreciated that the novelty of the present invention may be realized by software. However, special hardware devices may also be configured to the specific functions of the present invention.

[00043] Reference is made now to Fig. 1, presenting is a block diagram that illustrates in general the process performed by the pre operative planning system according to one embodiment of the present invention. Image Acquisition Module 10 receives images from various sources such as: DICOM Files 1, Digital Camera Pictures 2, Scanner Files 3, Custom API images 4, or any other source for medical images. Typically, X-Ray imaging is the common way to acquire images of hard tissues such as bones, however any medical imaging may be used for acquisition of the relevant medical images. X-Ray image on film may be scanned by a regular digital scanner to produce a digital Scanner file 3 of the image. Image Acquisition Module 10 is also responsible for calibration and scaling. Calibration and scaling may include various operations of image enhancements that are commonly used in displaying of images. Images may be enhanced by performing histogram equalization, brightness and contrast adjustments, edge detection, etc. Calibration and scaling may also include dimension calibration for registration with additional objects such as fixation elements as will be explained hereinafter. A common way for acquiring a real dimension unit in the image is to add an object of a known length to be imaged with the imaged subject. Calibration and scaling may also include correction for image distortion as many imaging devices create distortion during imaging. Distortion correction may be performed by applying non-linear

correction functions on the original image. These functions are typical to an imaging device and once these functions are created, any image taken by the device may be corrected and the distortion may be reduced to an acceptable minimum. The next step to be performed by the Image Acquisition Module 10 of the pre-planning system of the present invention is creating mathematical relationship between the two projections or views of the organs. This mathematical relationship may be used for automatically updating one view when the other view is manually altered, or for creating three dimensional data structure of the objects in the images. Patient details 11 are attached to the medical images. Image Rendering 15 is a step in which separate images of different parts of an organ may be composed and integrated to a full image of the organ. This step will be further described hereinafter. Then, Analysis 20 is performed assisted by measurement applications 25. The analysis determines whether an intervention is required. In case an intervention is required, the next step is Manipulation of segmented images 30.

[00044] In case of a trauma, the common treatment in orthopaedic procedures is fracture reduction. Fracture reduction in accordance with the present invention will be described in details hereinafter. The next step is Application and manipulation fixation elements 40. During this step, fixation elements are selected from a predefined set of standard fixation elements, or customized and designed specifically for the special need of a particular procedure. A template on the display may include various elements of various parameters, and drag-and-drop, move, and rotate functions on the display may define and locate the fixation in the required place. The fixation element, after defined by the medical expert, will be displayed at the right size according to the scale of the image (e.g., zoom), with accordance to the actual dimension of the fixation element. Fixation elements may be also selected and defined using a special keyboard that may be designed for this system. Planning result 60 is the output of the process. Planning result 60 may include images describing the final desired result of the orthopedic procedure, inventory report of fixation elements that were selected for the procedure, other result alternatives that were not selected to be performed. Planning result 60 may be stored, reviewed, printed or communicated to other systems. Various outputs may be created from planning result 60 such as Case report 90, OR equipment request 80 and Comparison of follow up images 70. The system of the present invention may also

be used for Post Op follow up 100 and for Result review 50 when an intervention is not required. In addition to trauma cases, the pre planning system of the present invention may also be used in other cases such as osteotomy as will be described in details hereinafter.

[00045] Reference in now made to Fig. 2A and Fig. 2B, that are schematics of X-Ray images of different views of a broken bone. A broken bone is a common case of trauma. The X-Ray images of Figs. 2A and 2B represent medical X-Ray images displayed on the display of the pre planning system of the present invention. These X-Ray images at this step are already calibrated and registered as explained hereinbefore (Fig. 1). Bone 220 of Fig. 2A is also demonstrated in different view as bone 260 of Fig. 2B. Similarly, bone segments 200 and 210 of Fig. 2A are also demonstrated in different view as bone segments 240 and 250 of Fig. 2B correspondingly. Fracture 230 of Fig. 2A is also demonstrated in Fig. 2B as fracture 270. It is obvious that bone segments 200 and 210 of Fig. 2A, and corresponding bone segments 240 and 250 of Fig. 2B, are segments of the same bone that is broken to two segments. The preferred medical treatment should obviously include reducing the fracture and fix the bone segments together.

[00046] Reference is now made to Figs. 3A, 3B, 4A and 4B that demonstrate the different steps composing pre planning of fracture reduction according to the present invention.

[00047] Fig. 3A and Fig 3B demonstrate the step of defining and marking a bone segment of the image that will be relatively moved on the display in order to simulate a different location of an organ. In the trauma case described here, it is desired to move a bone segment 310 of Fig. 3A and similarly the same bone segment 350 of Fig.3B in order to reduce a bone fracture. Bone segments 300 and 320 of Fig. 3A and corresponding bone segments 340 and 360 of Fig. 3B are not marked in this case. Marks 380 of Fig. 3A and marks 390 of Fig. 3B are inserted to the images manually by the medical expert. Alternatively, defining and marking of segments may be performed automatically by the preplanning system of the present invention using image processing techniques such as pattern recognition. Yet another option is that defining and marking is performed semi automatically by the pre planning system with interactive assistance of the medical expert.

[00048] Figs. 4A and 4B are schematic views of X-Ray image of a reduced fracture. Bone segment 310 Of Fig. 3A is moved to a new location on the image. The new location is demonstrated in Fig. 4A, and the moved segment 410 is still marked by marks 480. The medical expert is using standard interactive drag-and-drop capability to interactively move segment 410 on the display. It is obvious on Fig. 4A that the fracture has been reduced and bone segments 400 and 410 are located as close as possible to the original situation before the bone was broken to the two said segments.

[00049] Fig 4B illustrates a different view of the reduced fracture of Fig. 4A. The marks are not presented in order to improve observation of detail during the pre planning. The marks can be displayed or alternatively removed on both views as requested by the medical expert.

[00050] Fig 5A and Fig. 5B demonstrate the process of Application and manipulation of fixation elements 40 of Fig. 1. The base images are the reduced fracture images of Fig. 4A and 4B. The medical expert chooses a plate and screws as fixation elements. The plate and one screw are demonstrated as 510 and 520 in Fig. 5A and 530 and 540 in Fig. 5B correspondingly. The medical expert manually chooses the plate from a pre-defined set, or alternatively he may design a customized plate for a specific case. The plate is places in the preferred place along the broken bone. Then, a screw 520 and 540 of Figs. 5A and 5B correspondingly is selected from a pre-defined set of screws and again manually placed in the proper place. Interactive functions like drag-and-drop and rotate may be used interactively to perform the selection and placing of the fixation elements. When a fixation element is moved and placed manually on one View by the medical expert, the pre planning system of the present invention may place automatically the fixation element on the other view using the registration data obtained in Image Acquisition Module 10 of Fig. 1.

[00051] Fig. 6A and Fig. 6B demonstrate the two views of a final desired fixation application as pre planned by the pre planning system of the present invention. The fixation plate 610 and 630 of Figs. 6A and 6B correspondingly is fixed to the bone segments by screws 620 and 640 of Figs. 6A and 6B

correspondingly. The medical staff is able to use the pre operative plan of Figs. 6A and 6B during a surgical orthopedic procedure on the patient.

[00052] Figs. 7A and 7B demonstrate the actual postoperative result including actual plate 710 of Fig 7A, and actual screws 730 of Fig. 7B. The postoperative result may be compared to the pre operative plan for evaluating the results of the surgical procedure and for educational purposes.

[00053] Reference is now made to Figs 8A and 8B, that illustrate rendering of fixation elements.

[00054] In Fig. 8A, a Screw Head 810 is selected together with Screw Shaft 820, and a Screw Tip 830. Additional parameters and rules are selected from Predefined set of rules 840, and the system composes the Screw Rendered 850. Various screw as well as other elements can be defined using the same method, and it should be noted that fixation elements that are rendered this way are predefined to be available from a physical inventory.

[00055] Fig. 8B demonstrates composition of a fixation device composed of two fixation elements: Fixation Device Component A 870 and Fixation Device Component B 860. Fixed Relationship Description 880 defines the geometric relative positioning of Fixation Device Component A 870 and Fixation Device Component B 860. Rendering Mechanism 890 is used for storing and displaying the fixation device in step 895.

[00056] Fig. 9 is a flowchart of the process of osteotomy with external artificial fixation devices in accordance with the present invention. The process describes a generic mechanism for measurement deformity parameters that are difficult to measure using manual tools. The method provides a mechanism for AP translation and angulations, LT translation and angulations, axial translation, that is well suited for 3D models.

[00057] Selection anatomical/mechanical axis 900 is followed by planning a corrective procedure 905. Reference fragment selection 910 also includes marking of some organ segments. In step 915, the geometry and level of osteotomy are selected. Step 920 includes automatic calculation of parameters describing

ambulation and translation. Calculation of impaction prevention 930 is necessary for enabling the whole process of osteotomy. This step includes planning of actual movements of organ segments and fixation elements selected in step 940.The process is concluded in step 950, which is performing simulation of the procedure by rotating the non-reference fragment (segment) around the calculated Cora.

[00058] Fig. 10 is a detailed flowchart of automatic image rendering in accordance with the present invention. As explained hereinbefore, in Image rendering 15 of Fig. 1, separate images of different parts of an organ may be composed and integrated to a full image of the organ. The full image may be composed manually or automatically using image-processing algorithms. Fig. 10 illustrates automatic image rendering. It should be noted that many algorithms might be used for this purpose as part of the embodiment of the present invention. The algorithm described here is brought here just as one example. Acquisition of a set of images 1100 is followed by Quality reduction 1110. In step 1120 common points of several images are defined using pattern recognition and convolution techniques. Interactive manual assistance, namely Manual marking of common points 1130, which is performed by a medical expert may also be applied. As result, in step 1140 mathematical relationships between images is defined, and an image that is composed of various images may be displayed as an integral image.

[00059] Reference is made now to figure 11 that demonstrates the implementation of osteotomy simulation mechanism according to yet another embodiment of the present invention. It contains templates for frequent used surgical procedures such as high tibial osteototomy, or osteotomy of the first metatarsal of the foot (i.e., *Hallux Valgus*). It is acknowledged in this respect that other osteotomies, also those that are currently not fully implemented in the software, may also be preformed using the aforementioned manual osteotomy mechanism. The acquisition of images are displayed in diagram 11: at this first stage a medical professional is asked to select a procedure form a plurality of medical procedures supported by the software.

[00060] The software is presently an effective measurement tool for specific anatomy. The system can be automatic or must require an additional help of a medical professional place measurement tools on the specified anatomy. Once the

positioning of the anatomy is achieved, the system automatically calculates deformity parameters, such as angulations and translation. According to this embodiment and in a non-limiting manner, using these parameters, a recommendation can be made regarding the treatment type, as well as its necessity. Osteotomy type is selected, including wedge geometry, and center of rotating and angulations and translation is automatically determined by the system or set manually by the medical professional. The System automatically performs the corrective procedure on the x-ray image, providing the surgeon with an output of how the treated anatomical structure is going to be affected by the procedure.

[00061] It is also in the scope of the present invention wherein a non standard procedure is provided. The Medical professional is directed to manually apply measurement tools, e.g., standard tools as ruler, angle tool, orthogonal line tool, as well as other tools, which assist in determining the nature of the pathology. Accordingly, the physician can select the rotating and moving parts of the anatomy taking into account osteotomy level and wedge geometry. Subsequently, he is advised to move or rotate one or more of the affected structures towards the desired position according to the geometry of the desired procedure.